<u>What is claimed is</u>:

1. A method for cleaning glass substrates comprising immersing a glass substrate having lanthanide oxide particles thereon in an acid bath comprising nitric acid, hydrogen peroxide and an organic acid having a carboxylic acid group.

2. The method of claim 1, wherein the glass substrate is an aluminosilicate glass.

3. The method of claim 1, wherein the lanthanide oxide particles include at least one oxide of a lanthanum series element selected from the following: lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium.

4. The method of claim 1, wherein the lanthanide oxide particles include at least one of lanthanum oxide and cerium oxide.

5. The method of claim 1, wherein the glass substrate is immersed in the acid bath at a temperature of at least about 40°C.

6. The method of claim 1, wherein the glass substrate is immersed in the acid bath at a temperature of about 55°C to about 70°C.

7. The method of claim 1, wherein the nitric acid in the acid bath is at least about 1N nitric acid.

8. The method of claim 1, wherein the nitric acid in the acid bath is about 3N to about 4N nitric acid.

9. The method of claim 1, wherein the hydrogen peroxide in the acid bath is at least about 0.15N hydrogen peroxide.

10. The method of claim 1, wherein the hydrogen peroxide in the acid bath is about 0.15N to about 1N hydrogen peroxide.

11. The method of claim 1, wherein the organic acid is tartaric acid, citric acid, lactic acid, gluconic acid or edetic acid.

12. The method of claim 1, wherein the acid bath includes at least about 0.0067M organic acid.

13. The method of claim 1, wherein the acid bath includes about 0.02 to about 0.04M organic acid.

14. The method of claim 1, wherein the acid bath includes at least about 0.0067M tartaric acid.

15. The method of claim 1, wherein the acid bath includes about 0.02 to about 0.04M tartaric acid.

16. The method of claim 1, wherein the acid bath further includes about 0.03 to about 0.15 vol.% of a surfactant.

17. The method of claim 16, wherein the acid bath includes about 0.1 vol.% of the surfactant.

18. The method of claim 1, wherein the acid bath further includes up to about 1N sulfuric acid.

19. The method of claim 1, wherein the acid bath further includes up to about 40 g/l boric acid.

20. The method of claim 1, wherein the acid bath further includes aluminum ions.

21. The method of claim 20, wherein the acid bath includes up to about 0.005N $Al(NO_3)_3 \cdot 9H_2O$.

22. The method of claim 1, wherein the glass substrate is immersed in the acid bath for at least about 4 minutes.

23. The method of claim 1, wherein the glass substrate is immersed in the acid bath for about 4 minutes to about 5 minutes.

24. The method of claim 1, further comprising scrubbing the glass substrate with polyvinyl alcohol pads and potassium hydroxide having a pH of between about 9 and about 12.

25. The method of claim 24, further comprising immersing the glass substrate in a basic bath of potassium hydroxide having a pH of between about 11.5 and about 13 subsequent to the step of immersing the glass substrate in the acid bath.

26. The method of claim 1, further comprising subsequently subjecting the glass substrate to chemical strengthening, and immersing the glass substrate in a mild etching bath comprising a surfactant and an acid selected from the group of organic acids and sulfuric acid.

27. The method of claim 1, further comprising subsequently subjecting the glass substrate to chemical strengthening, and immersing the glass substrate in a mild etching bath comprising nitric acid, boric acid, hydrogen peroxide and an organic acid having a carboxylic acid group.

28. A method for cleaning glass substrates comprising:

immersing a glass substrate having lanthanide oxide particles thereon in an acid bath comprising at least about 1N nitric acid, at least about 0.15N hydrogen peroxide and at least about 0.0067M tartaric acid; and

subsequently immersing the glass substrate in a basic bath of potassium hydroxide having a pH of between about 11.5 and about 13.

29. The method of claim 28, wherein the glass substrate is an aluminosilicate glass.

30. The method of claim 28, wherein the lanthanide oxide particles include at least one of lanthanum oxide and cerium oxide.

31. The method of claim 28, wherein the glass substrate is immersed in the acid bath at a temperature of at least about 40°C.

32. The method of claim 28, wherein the glass substrate is immersed in the acid bath at a temperature of about 55°C to about 70°C.

33. The method of claim 28, wherein the nitric acid in the acid bath is about 3N to about 4N nitric acid.

34. The method of claim 28, wherein the hydrogen peroxide in the acid bath is about 0.15N to about 1N hydrogen peroxide.

35. The method of claim 28, wherein the acid bath includes about 0.02 to about 0.04M tartaric acid.

36. The method of claim 28, wherein the acid bath further includes about 0.03 to about 0.15 vol.% of a surfactant.

37. The method of claim 36, wherein the acid bath includes about 0.1 vol.% of the surfactant.

38. The method of claim 28, wherein the acid bath further includes up to about 1N sulfuric acid.

39. The method of claim 28, wherein the acid bath further includes up to about 40 g/l boric acid.

40. The method of claim 28, wherein the acid bath further includes aluminum ions.

41. The method of claim 40, wherein the acid bath includes up to about 0.02N $Al(NO_3)_3 \cdot 9H_2O$.

42. The method of claim 28, wherein the glass substrate is immersed in the acid bath for at least about 4 minutes.

43. The method of claim 28, wherein the glass substrate is immersed in the acid bath for about 4 minutes to about 5 minutes.

44. The method of claim 28, further comprising scrubbing the glass substrate with polyvinyl alcohol pads and potassium hydroxide having a pH of between about 9 and about 12.

45. The method of claim 28, further comprising subsequently subjecting the glass substrate to chemical strengthening, and immersing the glass substrate in a mild etching bath comprising a surfactant and an acid selected from the group of tartaric acid and sulfuric acid.

46. The method of claim 28, further comprising subsequently subjecting the glass substrate to chemical strengthening, and immersing the glass substrate in a mild etching bath comprising nitric acid, boric acid, hydrogen peroxide and an organic acid having a carboxylic acid group.

47. A method for cleaning glass substrates comprising:

(a) polishing a glass substrate with a slurry comprising lanthanide oxide particles;

(b) ultrasonically cleaning the substrate;

(c) mechanically scrubbing the substrate with soap and a pad;

(d) immersing the substrate in an acid bath comprising nitric acid, hydrogen peroxide and an organic acid having a carboxylic acid group;

(e) scrubbing the substrate with polyvinyl alcohol pads and potassium hydroxide; and

(f) immersing the substrate in a basic bath of potassium hydroxide.

48. The method of claim 47, further comprising:

(g) subjecting the substrate to chemical strengthening;

(h) immersing the substrate in an etching bath of a surfactant and an acid selected from the group of organic acids and sulfuric acid;

(i) again scrubbing the substrate with polyvinyl alcohol pads and potassium hydroxide; and

(j) again immersing the substrate in a basic bath of potassium hydroxide.

49. The method of claim 48, wherein steps (a)-(j) are each carried out for a time sufficient to reduce the content of lanthanide particles on the glass substrate to less than about 1.52×10^{-4} ng/mm^2 each after step (j).

50. A method for manufacturing a disk, comprising:

polishing a glass substrate with a slurry comprising lanthanide oxide particles; and

cleaning the polished glass substrate to remove said lanthanide oxide particles, said cleaning step leaving no more than about 1.52×10^{-4} ng/mm^2 of each type of lanthanide oxide on said glass substrate.

51. The method of claim 50, wherein said cleaning step comprises immersing the substrate in an acid bath comprising nitric acid, hydrogen peroxide and an organic acid having a carboxylic acid group.

52. A glass substrate having a polished surface comprising less than about 1.52×10^{-4} ng/mm^2 each of oxide particles of lanthanide series elements selected from the following: lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium.

53. The glass substrate of claim 52, wherein the glass is aluminosilicate glass.

54. The glass substrate of claim 52 produced by the method of:

polishing the glass substrate with a slurry to an atomically smooth finish, the slurry comprising at least one oxide of a lanthanide series element;

immersing the polished glass substrate having residual lanthanide oxide particles thereon in an acid bath comprising at least about 1N nitric acid, at least about 0.15N hydrogen peroxide and at least about 0.0067M tartaric acid; and

thereafter immersing the glass substrate in a basic bath of potassium hydroxide having a pH of between about 11.5 and about 13.

55. A glass substrate having a polished surface comprising less than about 1.52×10^{-4} ng/mm^2 each of oxide particles of lanthanide series elements selected from the following: lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium, said substrate produced by the method of claim 47.

56. A glass substrate having a polished surface comprising less than about 1.52×10^{-4} ng/mm^2 each of oxide particles of lanthanide series elements selected from the following: lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium, said substrate produced by the method of claim 48.

57. A disk drive product comprising a glass substrate having a polished surface comprising less than about 1.52×10^{-4} ng/mm^2 each of oxide particles of lanthanide series elements selected from following: lanthanum, cerium, praseodymium, neodymium, promethium, samarium, europium, gadolinium, terbium, dysprosium, holmium, erbium, thulium, ytterbium, and lutetium.

58. The disk drive product of claim 57, wherein the glass substrate is aluminosilicate glass.

CLAIMS

1. A self-cleaning colloidal slurry composition for superfinishing a surface of a substrate, the self-cleaning colloidal slurry composition comprising:

a carrying fluid;

colloidal particles;

etchant for etching the substrate;

a surfactant adsorbed and/or precipitated onto a surface of at least one of the substrate and the colloidal particles, the surfactant having a hydrophobic section that forms a steric hindrance barrier between the substrate and the colloidal particles.

2. The self-cleaning colloidal slurry composition as recited in claim 1, wherein the substrate is selected from a group consisting of a glass disk substrate, a ceramic disk substrate, and a glass-ceramic disk substrate for use in a data storage device.

3. The self-cleaning colloidal slurry composition as recited in claim 2, wherein the substrate is a silicate-based glass disk substrate.

4. The self-cleaning colloidal slurry composition as recited in claim 1, wherein the colloidal particles include colloidal silica particles, the surfactant is a nonionic surfactant and/or cationic, and the self-cleaning colloidal slurry composition has a pH of approximately 0 to 4.

5. The self-cleaning colloidal slurry composition as recited in claim 4, wherein the self-cleaning colloidal slurry composition has a pH of approximately 0.8 to 3.0.

6. The self-cleaning colloidal slurry composition as recited in claim 5, wherein the self-cleaning colloidal slurry composition has a pH of approximately 1.0 to 2.0.

7. The self-cleaning colloidal slurry composition as recited in claim 1, wherein the colloidal particles include colloidal silica particles, the surfactant is a cationic quaternary amine surfactant, and the self-cleaning colloidal slurry composition has a pH of approximately 7 to 12.

8. The self-cleaning colloidal slurry composition as recited in claim 1, wherein the colloidal particles include colloidal alumina or colloidal silica coated with alumina, and the self-cleaning colloidal slurry composition has a pH of approximately 3.5 to 10.5.

9. The self-cleaning colloidal slurry composition as recited in claim 4, wherein the colloidal silica particles have a nominal size of approximately 2 - 200 nm.

10. The self-cleaning colloidal slurry composition as recited in claim 6, wherein the colloidal silica particles include colloidal silica spheres having a nominal size of approximately 7 nm.

11. The self-cleaning colloidal slurry composition as recited in claim 3, wherein the etchant is a metal etchant selected from a group consisting of Ce, Zr, Ti, Fe, Sn, Al, Cr, Ni, Mn and Zn, and combinations thereof, and wherein the metal etchant is present in solution and/or as a colloid and/or as an ion on the colloidal particles.

12. The self-cleaning colloidal slurry composition as recited in claim 1, wherein the etchant is an acid or base solution.

13. The self-cleaning colloidal slurry composition as recited in claim 1, wherein the surfactant is a nonionic and/or cationic surfactant selected from a group consisting of oxygen containing compounds and nitrogen containing compounds, and combinations thereof.

14. The self-cleaning colloidal slurry composition as recited in claim 13, wherein the nonionic surfactant is an oxygen containing compound with moieties of ethylene oxide and/or polyvinyl alcohol.

15. The self-cleaning colloidal slurry composition as recited in claim 13, wherein the nonionic and/or cationic surfactant is a nitrogen containing compound selected from a group consisting of alkaloids and amines, and combinations thereof.

16. The self-cleaning colloidal slurry composition as recited in claim 13, wherein the nonionic and/or cationic surfactant is a polydentate adsorption surfactant.

17. The self-cleaning colloidal slurry composition as recited in claim 1, wherein the surfactant is a cationic surfactant.

18. The self-cleaning colloidal slurry composition as recited in claim 1, wherein the surfactant is selected from a group consisting of anionic surfactants and quaternary amine surfactants.

19. A process for superfinishing a surface of a substrate, the process comprising the steps of:

applying a self-cleaning colloidal slurry to the surface of the substrate, the self-cleaning colloidal slurry comprising

a carrying fluid,

colloidal particles,

etchant for etching the substrate,

a surfactant adsorbed and/or precipitated onto a surface of at least one of the substrate and the colloidal particles, the surfactant having a hydrophobic section that forms a steric hindrance barrier between the substrate and the colloidal particles;

mechanically rubbing the surface of the substrate with a pad while contacting the surface of the substrate with the self-cleaning colloidal slurry.

20. The process as recited in claim 19, wherein the substrate is selected from a group consisting of a glass disk substrate, a ceramic disk substrate, and a glass-ceramic disk substrate for use in a data storage device.

21. The process as recited in claim 20, wherein the substrate is a silicate-based glass disk substrate.

22. The process as recited in claim 19, wherein the surfactant is a nonionic and/or cationic surfactant selected from a group consisting of oxygen containing compounds and nitrogen containing compounds, and combinations thereof.

23. The process as recited in claim 22, wherein the nonionic surfactant is an oxygen containing compound with moieties of ethylene oxide and/or polyvinyl alcohol.

24. The process as recited in claim 22, wherein the nonionic and/or cationic surfactant is a nitrogen containing compound selected from a group consisting of alkaloids and amines, and combinations thereof.

25. The process as recited in claim 22, wherein the nonionic and/or cationic surfactant is a polydentate adsorption surfactant.

26. The process as recited in claim 19, wherein the surfactant is a cationic surfactant.

27. The process as recited in claim 19, wherein the surfactant is selected from a group consisting of anionic surfactants and quaternary amine surfactants.

28. The process as recited in claim 19, further comprising the step of cleaning the surface of the substrate using standard soap solutions, wherein the cleaning step is performed after the step of mechanically rubbing the surface of the substrate with the pad while contacting the surface of the substrate with the self-cleaning colloidal slurry, and wherein the cleaning step removes substantially all of the remaining contamination from the surface of the substrate, the remaining contamination being at least partially due to the colloidal particles in the self-cleaning colloidal slurry.

29. A disk substrate for use in a data storage device, the disk substrate comprising:

substrate material having a surface roughness of less than 2 Å; the substrate material being selected from a group consisting of glass, ceramic, and glass-ceramic; and the substrate material having essentially no surface contamination even though the surface of the substrate material was not subjected to a cleaning process that utilized etching or micropolishing or cleaning polish etch, or a combination thereof, to remove contaminants therefrom.

30. The disk substrate as recited in claim 29, wherein the substrate material is a silicate-based glass.

31. A data storage disk for use in a data storage device, comprising:

a disk substrate comprising a substrate material having a surface roughness of less than 2 Å; the substrate material being selected from a group consisting of glass, ceramic, and glass-ceramic; and the substrate material having essentially no surface contamination even though the surface of the substrate material was not subjected to a cleaning process that utilized etching or micropolishing or cleaning polish etch, or a combination thereof, to remove contaminants therefrom;

a recording layer applied over at least one surface of the disk substrate.

32. The data storage disk as recited in claim 31, wherein the substrate material is a silicate-based glass.

33. A data storage device, comprising:

a data storage disk comprising a disk substrate, the disk substrate comprising a substrate material having a surface roughness of less than 2 Å; the substrate material being selected from a group consisting of glass, ceramic, and glass-ceramic; the data storage disk further comprising a recording layer applied over at least one surface of the disk substrate; and the substrate material having essentially no surface contamination even though surface of the substrate material was not subjected to a cleaning process that utilized etching or micropolishing or cleaning polish etch, or a combination thereof, to remove contaminants therefrom;

a transducer;

an actuator provided to position the transducer relative to the data storage disk;

a motor provided to rotate the storage disk relative to the transducer.

34. The data storage device as recited in claim 33, wherein the substrate material is a silicate-based glass.

35. A self-cleaning colloidal slurry composition for finishing a surface of a substrate, the self-cleaning colloidal slurry composition comprising:

a carrying fluid;

colloidal particles;

etchant for etching the substrate;

a surfactant adsorbed and/or precipitated onto a surface of at least one of the substrate and the colloidal particles, the surfactant having a hydrophobic section that forms a steric hindrance barrier between the substrate and the colloidal particles.

36. The self-cleaning colloidal slurry composition as recited in claim 35, wherein the colloidal particles have a nominal size of approximately 70 - 200 nm to provide a textured surface on the substrate.

37. A process for finishing a surface of a substrate, the process comprising the steps of:

applying a self-cleaning colloidal slurry to the surface of the substrate, the self-cleaning colloidal slurry comprising

a carrying fluid,

colloidal particles,

etchant for etching the substrate,

a surfactant adsorbed and/or precipitated onto a surface of at least one of the substrate and the colloidal particles, the surfactant having a hydrophobic section that forms a steric hindrance barrier between the substrate and the colloidal particles;

mechanically rubbing the surface of the substrate with a pad while contacting the surface of the substrate with the self-cleaning colloidal slurry.

38. The process as recited in claim 37, further comprising the step of cleaning the surface of the substrate using standard soap solutions, wherein the cleaning step is performed after the step of mechanically rubbing the surface of the substrate with the pad while contacting the surface of the substrate with the self-cleaning colloidal slurry, and wherein the cleaning step removes substantially all of the remaining contamination from the surface of the substrate, the remaining contamination being at least partially due to the colloidal particles in the self-cleaning colloidal slurry.

39. The process as recited in claim 37, wherein the step of mechanically rubbing the surface of the substrate with a pad while contacting the surface of the substrate with the self-cleaning colloidal slurry provides a textured surface on the substrate.